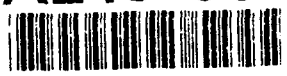

(2)

Wallis Normalization Image Enhancement Tactical Support System (TESS (3)) Documentation

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These working papers were prepared for the timely dissemination of information; this document does not represent the official position of NOARL.

Abstract

The Wallis Normalization Image Enhancement (WNIE) software module is a general purpose digital processing function that normalizes the pixel values for a given input image. The process permits the user to accept default values or input the desired mean and standard deviation required for the output image. The function creates a new image that raises the contrast in low contrast regions and lowers the contrast in those sections that are too high. This allows the user to view the entire image with one enhancement that brings out the majority of features, whether they be sea surface temperature gradients in an infrared ocean image or sea ice features (floes, leads, etc.) in a visible or infrared polar image. The speed and flexibility of the wallis filter is a powerful tool the operator can implement to increase the image content readily extracted.

Acknowledgments

Software rehosting to the Tactical Environmental Support System (TESS(3)) was accomplished by Walt Osterman (Sverdrup Technology, Inc. Documentation of this technical note was streamlined with the help of Mark Boston (NAVOCEANO) and carried out by the coauthors. This work was supported by the Chief of Naval Operations (OP-096), the Space and Naval Warfare Systems Command (SPAWAR) Satellite Applications and Technology Program, Program Element No. 0603704N, CDR Peter Ranelli, Program Manager.

SOFTWARE REQUIREMENTS SPECIFICATION

For The

WALLIS NORMALIZATION IMAGE ENHANCEMENT (WNIE)

SOFTWARE REQUIREMENTS SPECIFICATION FOR THE WALLIS NORMALIZATION IMAGE ENHANCEMENT

1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Wallis Normalization Image Enhancement (WNIE) Version 1.0, is a software module targeted for implementation on the MASSCOMP to normalize a display image. The WNIE software will provide the analyst with enhanced means to visually locate sea surface temperature gradients and sea ice features.

1.2 CSCI Overview

WNIE, based on the Wallis normalization algorithm, performs a space variant contrast stretch to normalize a display image.

1.3 Document Overview

This Software Requirements Specification (SRS) establishes the requirements for the CSCI identified as the WNIE software.

2.0 APPLICABLE DOCUMENTS

The following document of the exact issue shown forms a part of this specification to the extent specified herein. In the event of conflict between the document referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

"System 600 Version 2.0 Command Reference Volume 2", International Imaging Systems, August 1987.

3.0 ENGINEERING REQUIREMENTS

3.1 CSCI External Interface Requirements

The following items constitute the external menu interface required for the WNIE.

list	-	lists all menu options to the users terminal
init	-	initialize input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc, to default values

setp	-	allows the user to set input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc
run	-	enter the input and output file names and execute the Wallis Normalization algorithm
disp	-	display the input or output file
clr	-	clear the display screen
end	-	end the program

3.2 CSCI Capability Requirements

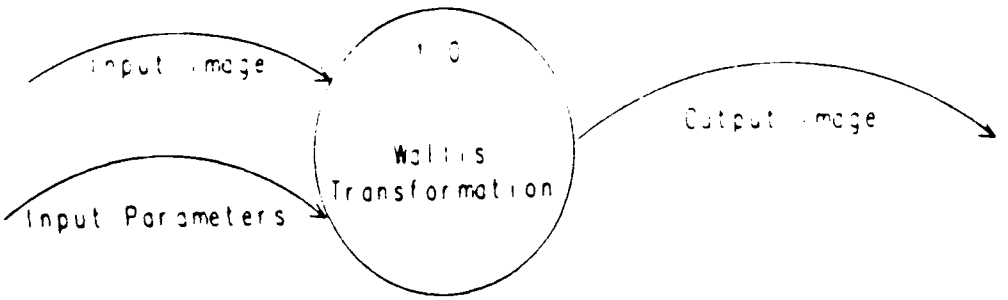
The WNIE shall perform a space variant contrast stretch to normalize the input display image using the Wallis algorithm. The computational algorithm has the following form:

```
X'(S,L) = SQRT([DSVAR]/[VAR+EPS]) * [X(S,L)-MEAN] +
          alpha*desiredMean + (1-alpha)*MEAN
```

where:

S	= Samples coordinate.
L	= Line coordinate.
X'(S,L)	= Normalized pixel intensity at coordinates S,L.
X(S,L)	= Original pixel intensity at coordinates S,L.
MEAN	= Local mean.
VAR	= Localized variance (localized standard deviation**2) (local neighborhood defined by WINDOW parameter).
desiredMean	= Desired mean.
DSVAR	= Desired variance (standard deviation**2).
EPS	= (1/MAXGAIN) - to restrict the maximum gain.
alpha	= Factor to govern mean value shifting (between 0 and 1)

3.3 CSCI Internal Interfaces



Data Definitions

Input Image - 8 bit byte binary image file.

Input Parameters - User supplied input to control the normalization process.

Output Image - 8 bit binary byte image file.

Process Definitions

Wallis Transformation - creates a normalized output image by applying the Wallis Normalization algorithm to the input image.

3.4 CSCI Data Element Requirements

Input image (inImage) - ASCII character string, no default.

Output image (outImage) - ASCII character string, no default.

Desired mean (desiredMean) - Real, default = 128.0,
$0.0 \leq$ desiredMean ≤ 255.0.

Desired deviation (desiredDev) - Real, default = 76.8,
$1.0 \leq$ desiredDev ≤ 255.0

Window (window) - Integer, default = 41, window > 3.

Maximum gain (maxGain) - Real, default = 6.0,
$0.0 \leq$ maxGain ≤ 255.0.

Alpha (alpha) - Real, default = 0.8, $0.0 \leq$ alpha.

Sample Increment (sampleInc) - Integer, default = 3,
sampleInc ≥ 1.

Line Increment (lineInc) - Integer, default = 3,
lineInc $\geq$ 1.

3.5 Adaption Requirements

Not applicable.

3.6 Sizing And Timing Requirements

WNIE will normalize a byte file in two minutes or less when using the default input values.

3.7 Safety Requirements

Not applicable.

3.8 Security Requirements

Not applicable.

3.9 Design Constraints

Not applicable.

3.10 Software Quality Factors

Not applicable.

3.11 Human Performance

The values for the samples (x) direction increment and the line (y) direction increment must be selected with care. A large increment value for either direction will allow the WNIE 1.0 to run faster, but with less accurate results. A small increment value for either direction will produce more accurate results, but the time to run the WNIE 1.0 will increase tremendously. The suggested increment for the x and y direction is three (3).

3.12 Requirements Traceability

Not applicable.

4.0 QUALIFICATION REQUIREMENTS

Not applicable.

5.0 PREPARATION FOR DELIVERY

Not applicable.

6.0 NOTES

Abbreviations and Acronyms:

CSCI	- Computer Software Configuration Item
SRS	- Software Requirements Specification
WNIE	- Wallis Normalization Image Enhancement

SOFTWARE DESIGN DOCUMENT

For The

WALLIS NORMALIZATION IMAGE ENHANCEMENT (WNIE)

SOFTWARE DESIGN DOCUMENT
FOR THE
WALLIS NORMALIZATION IMAGE ENHANCEMENT

1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Wallis Normalization Image Enhancement (WNIE) Version 1.0, is a software module targeted for implementation on the MASSCOMP to normalize a display image. High contrast areas are toned down while low contrast regions are brightened by redistributing the pixel count value histogram. The WNIE software provides the analyst with a means to enhance sea surface temperature gradients and sea ice features across the entire image, even when illumination or temperatures change markedly across the sensor swath.

1.2 System Overview

WNIE, based on the Wallis Normalization algorithm, performs a space variant contrast stretch to normalize a display image.

1.3 Document Overview

This Software Design Document (SDD) describes the software design details of the WNIE software.

2.0 REFERENCED DOCUMENTS

"Software Requirements Specification (SRS) For The Wallis Normalization Image Enhancement", Sverdrup Technology, Inc., September 1991.

3.0 PRELIMINARY DESIGN

3.1 CSCI Overview

WNIE will normalize a display image by using the Wallis Normalization algorithm to preform a space variant contrast stretch on the input image. This image enhancement provides the analyst with a means to enhance sea surface temperature gradients and sea ice features.

The following items constitute the external menu interface required for the WNIE software:

list	-	lists all program options to the user's terminal
init	-	initialize input parameters, desiredMean,

desiredDev, window, maxGain, alpha, sampleInc, and lineInc, to default values

setp - allows the user to set input the parameters desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc

run - enter the input and output image file names and execute the Wallis Normalization algorithm

disp - display the input or output file

clr - clear the display screen

end - end the program

3.1.1 CSCI Architecture

The WNIE is composed of two Computer Software Components (CSCs), WALLIS and DNORM. WALLIS is the interface CSC. WALLIS will receive and validate input, open the input and output images, calculate offsets, call DNORM, and close the input and output files. DNORM will read the input image, normalize the input image using the Wallis algorithm, and write the output image.

The following items constitute the WALLIS to DNORM interface:

Input image (inImage) - Source image to be normalized.

Output image (outImage) - Destination image (normalized).

Desired mean (desiredMean) - Desired mean.

Desired deviation (desiredDev) - Desired standard deviation.

Window (window) - Size of the square data window for computation of the local standard deviation (VAR) and local mean (MEAN). Window must be an odd integer larger than three.

Maximum gain (maxGain) - Maximum gain.

Alpha (alpha) - Factor to govern mean value shifting.

Sample Increment (sampleInc) - Increment in the samples (x) direction for the calculation of the local statistics.

Line Increment (lineInc) - Increment in the line (y) direction for the calculation of the local statistics.

Number Samples (numSamples) - The number of samples in the image in the horizontal dimension.

Number lines (numLines) - The number of lines in the image in the vertical dimension.

Number bands (numBands) - The number of spectral bands.

Offsets (offsets) - offsets to gain, variance, mean, bias.

3.1.2 System States And Modes

Not Applicable

3.1.3 Memory And Processing Time Allocation

Not Applicable

3.2 CSCI Design Description

3.2.1 Wallis (WALLIS)

WALLIS receives the following data items, which compose the external menu interface of WNIE software.

list	-	lists all menu options to the user's terminal
init	-	initialize input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc, to default values
setp	-	allows the user to set input parameters, desiredMean, desiredDev, window, maxGain, alpha, sampleInc, and lineInc
run	-	enter the input and output file names and execute the Wallis Normalization algorithm
disp	-	display the input or output file
clr	-	clear the display screen
end	-	end the program

WALLIS is executed from the command line with the data items of the external interface. WALLIS validates input items, opens the input and output image files, and calls DNORM with the data items of the internal interface (see Section 3.1.1). When DNORM returns, WALLIS closes the input and output image files and

exits. The structure flow for WALLIS is shown in Figure 1.

3.2.2 Normalization (DNORM)

DNORM normalizes the input image by performing the Wallis algorithm as described in Section 4.2.2.

DNORM is called from WALLIS with the data items of the internal interface (see Section 3.1.1).

DNORM divides the input image into WINDOW sized subsets, calculates the local mean and variance for each window, and calculates the bias and gain needed for each window to normalize the output image to the desired mean and variance. DNORM applies the bias and gain to each point in the input file and writes the result to the output file. The structure flow for DNORM is shown in Figure 2.

4.0 DETAILED DESIGN

4.1 Wallis (WALLIS)

The WALLIS module the interface and control functions for the WNIE software.

4.1.1 WALLIS Design Specification

WALLIS receives and validates the data items of the external interface, opens the input image file and output image files, initialize data, allocates memory, and calls DNORM. When DNORM returns, WALLIS closes the input image file and the output image file, and exits.

4.1.2 WALLIS Design

The following is the pseudo code for the WALLIS module of the WNIE software.

```
WALLIS
     INPUT
          INIMAGE        - SOURCE IMAGE TO BE NORMALIZED
          OUTIMAGE       - DESTINATION IMAGE (NORMALIZED)
          DESIREDMEAN    - DESIRED MEAN
          DESIREDDEV     - DESIRED STANDARD DEVIATION
          WINDOW         - SIZE OF THE SQUARE DATA WINDOW
                           FOR COMPUTATION OF THE LOCAL
                           STANDARD DEVIATION (VAR) AND
                           LOCAL MEAN (MEAN)
          MAXGAIN        - MAXIMUM GAIN
          ALPHA          - FACTOR TO GOVERN MEAN VALUE
                           SHIFTING
          SAMPLEINC      - INCREMENT IN THE SAMPLES (X)
```

```
                              DIRECTION FOR THE CALCULATION OF
                              THE LOCAL STATISTICS
          LINEINC           - INCREMENT IN THE LINE (Y)
                              DIRECTION FOR THE CALCULATION OF
                              THE LOCAL STATISTICS
   COMMENT - WINDOW MUST BE AN ODD NUMBER GREATER THAN 3
   VALIDATE WINDOW

   OPEN INPUT IMAGE
   READ NUMSAMPLES FROM INPUT IMAGE
   READ NUMLINES FROM INPUT IMAGE
   READ NUMBANDS FROM INPUT IMAGE

   OPEN OUTPUT IMAGE

   CALCULATE OFFSET (MEANOF, VAROFF, GAINOF, BIASOF)


   CALL DNORM
      INPUT
           INIMAGE         - SOURCE IMAGE TO BE NORMALIZED
           OUTIMAGE        - DESTINATION IMAGE (NORMALIZED)
           DESIREDMEAN     - DESIRED MEAN
           DESIREDDEV      - DESIRED STANDARD DEVIATION
           WINDOW          - SIZE OF THE SQUARE DATA WINDOW
                             FOR COMPUTATION OF THE LOCAL
                             STANDARD DEVIATION (VAR) AND
                             LOCAL MEAN (MEAN)
           MAXGAIN         - MAXIMUM GAIN
           ALPHA           - FACTOR TO GOVERN MEAN VALUE
                             SHIFTING
           SAMPLEINC       - INCREMENT IN THE SAMPLES (X)
                             DIRECTION FOR THE CALCULATION OF
                             THE LOCAL STATISTICS
           LINEINC         - INCREMENT IN THE LINE (Y)
                             DIRECTION FOR THE CALCULATION OF
                             THE LOCAL STATISTICS
           NUMSAMPLES      - THE NUMBER OF SAMPLES IN THE
                             IMAGE IN THE HORIZONTAL
                             DIMENSION
           NUMLINES        - THE NUMBER OF LINES IN THE IMAGE
                             IN THE VERTICAL DIMENSION
           NUMBANDS        - THE NUMBER OF SPECTRAL BANDS
           OFFSETS         - OFFSETS TO GAIN, VARIANCE, MEAN,
                             BIAS


   CLOSE INPUT IMAGE
   CLOSE OUTPUT IMAGE

END WALLIS
```

4.2 Normalization (DNORM)

The DNORM module performs the normalization function of the WNIE.

4.2.1 DNORM Design Specification

DNORM normalizes the input image by performing a space variant contrast stretch based on the Wallis Normalization algorithm. DNORM divides the input image into WINDOW sized subsets, calculates the local mean and variance for each window, and calculates the bias and gain needed for each window to normalize the output image to the desired mean and variance. DNORM applies the bias and gain to each point in the input file and writes the result to the output file.

4.2.2 DNORM Design

DNORM performs a space variant contrast stretch to normalize the input display image using the Wallis algorithm. The computational algorithm has the following form:

```
X'(S,L) = SQRT([DSVAR]/[VAR+EPS]) * [X(S,L)-MEAN] +
      alpha*desiredMean + (1-alpha)*MEAN
```

where:

S	= Sample (x) coordinate.
L	= Line (y) coordinate.
X'(S,L)	= normalized pixel intensity at coordinates S,L.
X(S,L)	= original pixel intensity at coordinates S,L.
MEAN	= local mean.
VAR	= localized variance (localized standard deviation**2 (local neighborhood defined by WINDOW parameter).
desiredMean	= desired mean.
DSVAR	= desired variance (standard deviation**2).
MAXGAIN	= Maximum allowable gain.
EPS	= (1/MAXGAIN) - to restrict the maximum gain.
alpha	= factor to govern mean value shifting (between 0 and 1)

The following is the pseudo code for the DNORM module of the WNIE software.

```
DNORM
     INPUT
          INIMAGE        - SOURCE IMAGE TO BE NORMALIZED
          OUTIMAGE       - DESTINATION IMAGE (NORMALIZED)
          DESIREDMEAN    - DESIRED MEAN
```

```
        DESIREDDEV      - DESIRED STANDARD DEVIATION
        WINDOW          - SIZE OF THE SQUARE DATA WINDOW
                          FOR COMPUTATION OF THE LOCAL
                          STANDARD DEVIATION (VAR) AND
                          LOCAL MEAN (MEAN)
        MAXGAIN         - MAXIMUM GAIN
        ALPHA           - FACTOR TO GOVERN MEAN VALUE
                          SHIFTING
        SAMPLEINC       - INCREMENT IN THE SAMPLES (X)
                          DIRECTION FOR THE CALCULATION OF
                          THE LOCAL STATISTICS
        LINEINC         - INCREMENT IN THE LINE (Y)
                          DIRECTION FOR THE CALCULATION OF
                          THE LOCAL STATISTICS
        NUMSAMPLES      - THE NUMBER OF SAMPLES IN THE
                          IMAGE IN THE HORIZONTAL
                          DIMENSION
        NUMLINES        - THE NUMBER OF LINES IN THE IMAGE
                          IN THE VERTICAL DIMENSION
        NUMBANDS        - THE NUMBER OF SPECTRAL BANDS
        OFFSETS         - OFFSETS TO GAIN, VARIANCE, MEAN,
                          BIAS

FOR EACH X DIRECTION WINDOW
BEGIN
  FOR EVERY LINEINC LINE IN X WINDOW
  BEGIN
    READ X WINDOW FROM INPUT FILE
    FOR EACH Y DIRECTION WINDOW
    BEGIN
      FOR EVERY SAMPLEINC OF Y
      BEGIN
        CALCULATE LOCAL MEAN
        CALCULATE LOCAL VARIANCE
      END FOR EVERY SAMPLEINC OF Y
    END FOR EACH Y DIRECTION WINDOW
  END FOR EVERY LINEINC LINE IN X WINDOW

  FOR EACH Y WINDOW
  BEGIN
    CALCULATE GAIN FROM LOCAL VARIANCE
    CALCULATE BIAS FROM LOCAL MEAN
  END FOR EACH Y WINDOW

  FOR EACH Y WINDOW
  BEGIN
    CALCULATE GAIN INTERPOLATION MATRIX
    CALCULATE BIAS INTERPOLATION MATRIX
  END FOR EACH Y WINDOW

  FOR EACH LINE ACROSS X WINDOW
  BEGIN
```

```
        READ INPUT IMAGE BY NUMSAMPLES INCREMENTS

        FOR EACH Y WINDOW
        BEGIN
          CALCULATE GAIN FOR WINDOW TO ACHIEVE DESIRED
      DEVIATION
          CALCULATE BIAS FOR WINDOW TO ACHIEVE DESIRED MEAN

          FOR EACH INPUT POINT
          BEGIN
            CALCULATE NORMALIZED POINT VALUE X' = GAIN * X +
            BIAS
          END FOR EACH INPUT POINT
        END FOR EACH Y WINDOW

        WRITE NORMALIZED POINT VALUES TO OUTPUT IMAGE

      END FOR EACH LINE ACROSS X WINDOW

    END FOR EACH X DIRECTION WINDOW
```

5.0 CSCI DATA

Number Samples (numSamples) is the number of samples in the input image in the horizontal dimension. numSamples is an integer, calculated in WALLIS from the input image. numSamples is used in DNORM to traverse the input image.

Number lines (numLines) is the number of lines in the input image in the vertical dimension. numLines is an integer, calculated in WALLIS from the input image. numLines is used in DNORM to traverse the input image.

Number bands (numBands) is the number of spectral bands in the input image. numBands is an integer, calculated in WALLIS from the input image. numBands is used in DNORM to traverse the input image.

Offsets (offsets) are the offsets to the gain, variance, mean, and bias in the input image. offsets are integers, calculated in WALLIS from the input image. offsets are used in DNORM to find the gain, variance, mean, and bias of the input image.

6.0 CSCI DATA FILES

6.1 Data File To CSC/CSU Cross Reference

Input image - WALLIS, DNORM

Output image - WALLIS, DNORM

6.2 Input image (inImage)

inImage is the input image file. It is a 8-bit binary, random access file. inImage contains a single record that describes the nonnormalized image.

6.3 Output Image (outImage)

outImage is the output image file. It is a 8-bit binary, random access file. outImage contains a single record that describes the normalized image.

7.0 REQUIREMENTS TRACEABILITY

Not Applicable

8.0 NOTES

Abbreviations and Acronyms:

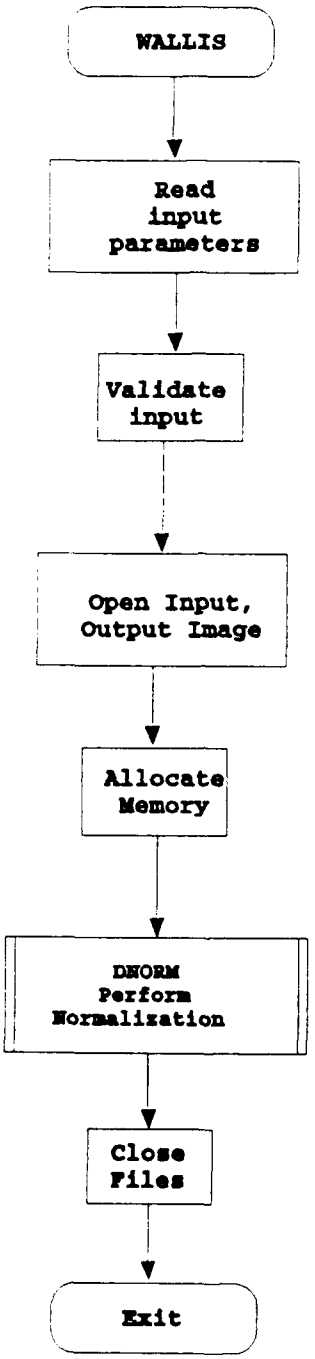
CSC	- Computer Software Component
CSCI	- Computer Software Configuration Item
CSU	- Computer Software Unit
SDD	- Software Design Document
SRS	- Software Requirements Specification
WNIE	- Wallis Normalization Image Enhancement

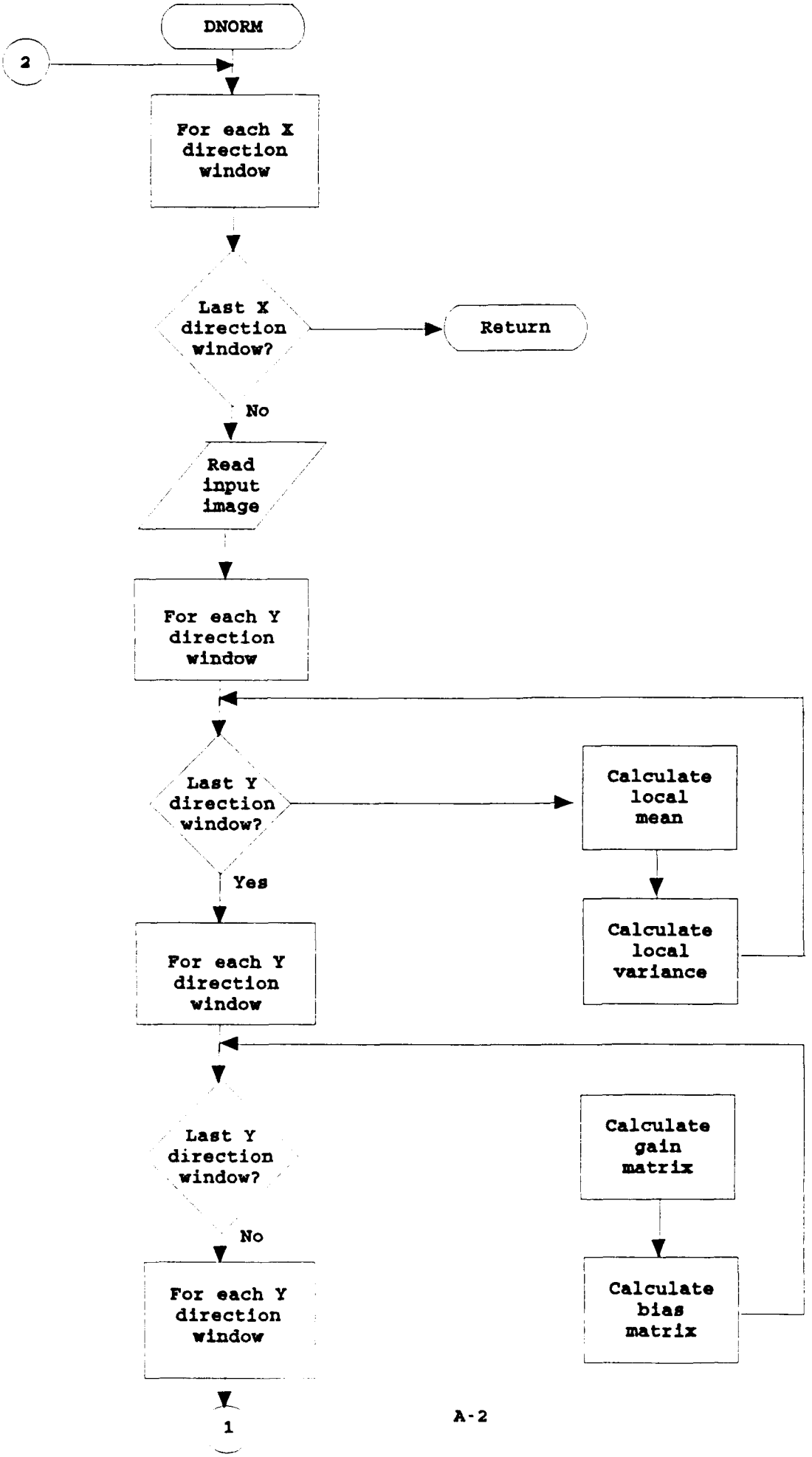
9.0 APPENDICES

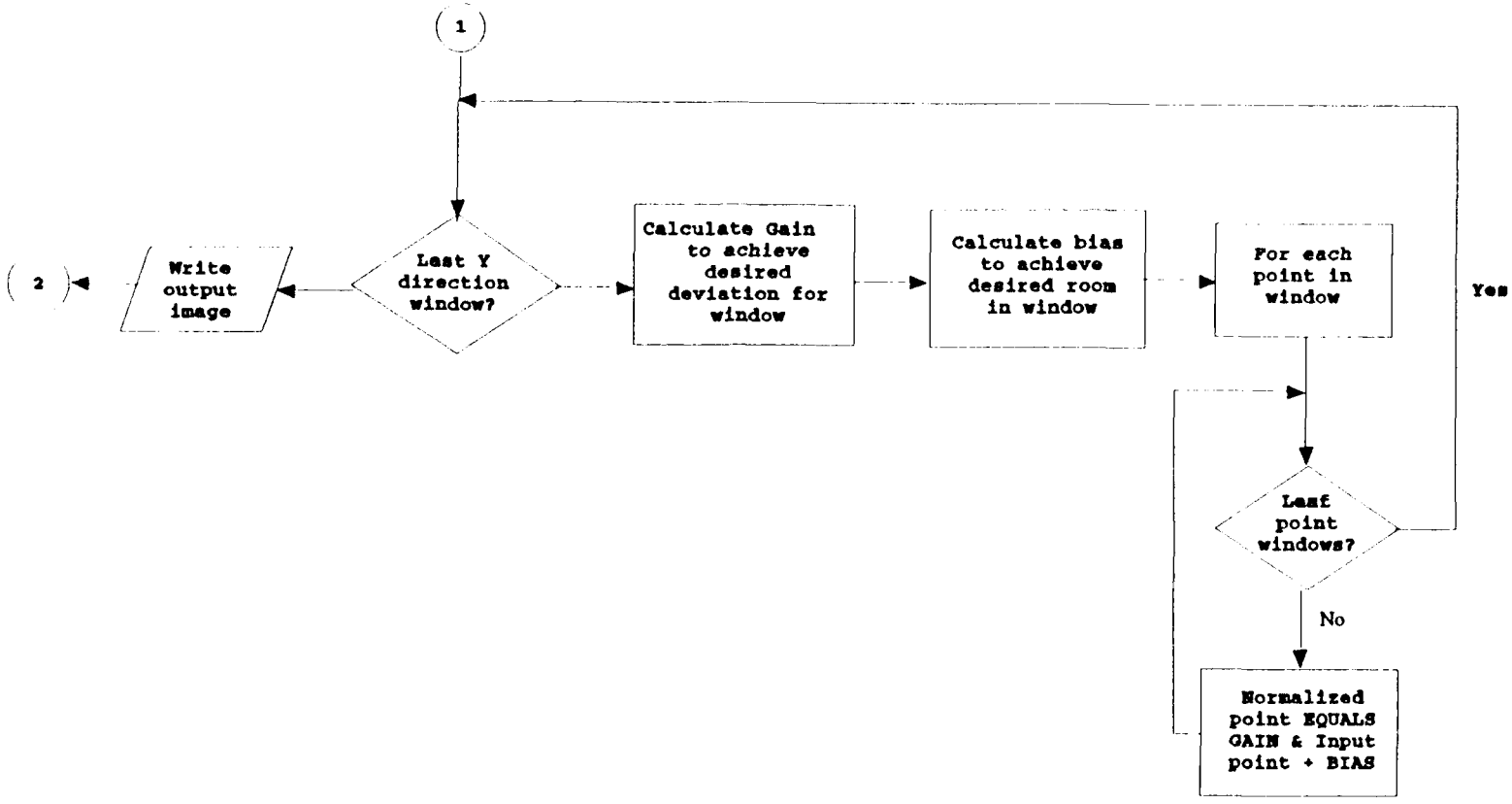
Appendix A contains the flow charts for the WNIE software modules, WALLIS and DNORM.

Appendix A

WNIE Flow Charts


WALLIS
Read input parameters
Validate input
Open Input, Output Image
Allocate Memory
DNORM Perform Normalization
Close Files
Exit


DNORM
2
For each X direction window
Last X direction window?
Return
No
Read input image
For each Y direction window
Last Y direction window?
Calculate local mean
Calculate local variance
Yes
For each Y direction window
Last Y direction window?
Calculate gain matrix
Calculate bias matrix
No
For each Y direction window
1


1
2
Write output image
Last Y direction window?
Calculate Gain to achieve desired deviation for window
Calculate bias to achieve desired room in window
For each point in window
Yes
Last point windows?
No
Normalized point EQUALS GAIN & Input point + BIAS

SOFTWARE TEST DESCRIPTION

For The

WALLIS NORMALIZATION IMAGE ENHANCEMENT (WNIE)

SOFTWARE TEST DESCRIPTION
FOR THE
WALLIS NORMALIZATION IMAGE ENHANCEMENT

1.0 SCOPE

1.1 Identification

The Computer Software Configuration Item (CSCI), identified as the Wallis Normalization Image Enhancement (WNIE) Version 1.0, is a software module targeted for implementation on the MASSCOMP to normalize a display image. The WNIE software provides the analyst with a means to visually enhance sea surface temperature gradients and sea ice features.

1.2 System Overview

WNIE Version 1.0, based on the Wallis normalization algorithm, performs a space variant contrast stretch to normalize a display image.

1.3 Document Overview

The purpose of this Software Test Description (STD) is to provide a test case and the test procedure necessary to perform formal qualification testing of the WNIE Version 1.0.

2.0 REFERENCED DOCUMENTS

"Software Requirement Specification (SRS) for the Wallis Normalization Image Enhancement (WNIE)", Sverdrup Technology, Inc., September 1991.

"Software Design Document (SDD) for the Wallis Normalization Image Enhancement (WNIE)", Sverdrup Technology, Inc., September 1991.

3.0 FORMAL QUALIFICATION TEST PREPARATIONS

Not applicable.

4.0 FORMAL QUALIFICATION TEST DESCRIPTIONS

The WNIE Software Test (WST) will validate the input parameters and produce a normalize output image from an input image. The following section describes the WST using an input test image containing ice and water.

4.1 Water And Ice Test Case (WAITC)

The WAITC will read an input image, **iceimage.dat**, consisting of areas of ice and water, and normalize the image to produce an

output image, **normimag.dat**. In **iceimage.dat**, the ice areas are high brightness and contrast, and the water areas are low brightness and contrast. In **normimag.dat**, the brightness and contrast of the ice and water will be lowered and raised respectively, to provide a more viewable image.

4.1.1 Water And Ice Test Case Requirements Traceability

In WAITC, WNIE will perform a space variant contrast stretch to normalize the input image, **iceimage.dat**, using the Wallis Normalization algorithm.

4.1.2 Water And Ice Test Case Initialization

No initialization is needed for the WAITC.

4.1.3 Water And Ice Test Case Test Inputs

The following are the images and default parameter values to be used for WAITC.

Input image	= **iceimage.dat** - Source image to be normalized.
Output image	= **normimag.dat** - Destination image (normalized).
Desired mean	= **128.0** - Desired mean, 0.0 <= MEAN <= 255.0.
Desired deviation	= **76.8** - Desired standard deviation, 1.0 <= DEV <= 255.0.
Window	= **41** - Size of the square data window for computation of the local standard deviation (VAR) and local mean (MEAN). Window must be an odd INT and larger than three.
Maximum gain	= **6.0** - Maximum gain, 0.0 <= GAIN <= 255.0.
Alpha	= **0.8** - Factor to govern mean value shifting, 0.0 <= ALPHA.
Sample Increment	= **3** - Increment in the samples (x) direction for the calculation of the local statistics, 1 <= SAMPINC.
Line Increment	= **3** - Increment in the line (y) direction for the calculation of the local statistics, 1 <= LINEINC.

4.1.4 Water And Ice Test Case Expected Test Results

WAITC will produce a normalized image file named **normimag.dat** in the current directory.

4.1.5 Water And Ice Test Case Criteria For Evaluating Results

To evaluate the WAITC, the pixel values of the input image, **iceimage.dat**, and the output image, **normimag.dat**, must be examined. A section listing of the input image is contained in Appendix A, and a section listing of the expected output image is contained in Appendix B. The resulting output image generated by the test case WAITC should match the expected results in Appendix B.

4.1.6 Water And Ice Test Case Test Procedure

To execute WAITC, enter the following commands:

1. Invoke the program by entering the command "**wallis**".
2. Enter "**init**" to initialize program variables to the default values.
3. Enter "**run**" to execute the normalization.
4. Enter "**iceimage.dat**" as the input image.
5. Enter "**normimag.dat**" as the output image.
6. Enter "**clr**" to clear the graphic screen.
7. Enter "**disp**" to display a image.
8. Enter "**normimag.dat**" to display the output image.
9. Enter "**clr end**" to clear the graphic screen and end the program.

4.1.7 Water And Ice Test Case Assumptions and Constraints

It is assumed that this test will be performed on a MASSCOMP GA1000 running UNIX (RTU 4.0A or higher), using the supplied WNIE programs.

5.0 NOTES

Abbreviations and Acronyms:

CSCI	- Computer Software Configuration Item
RTU	- Real Time UNIX
SDD	- Software Design Document
SRS	- Software Requirements Specification
STD	- Software Test Description
WAITC	- Water And Ice Test Case
WNIE	- Wallis Normalization Image Enhancement
WST	- WNIE Software Test

6.0 APPENDICES

A sample of the input test image is contained in Appendix A. A sample of the output test image is contained in Appendix B.

Appendix A

Input Test Image

Input Test Image: iceimage.dat

Lines \ Samples	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263
248	89	77	84	86	82	82	77	83	91	76	83	78	79	79	83	80
249	90	83	77	87	81	84	79	84	94	80	77	79	81	81	82	85
250	92	86	80	83	85	83	80	82	89	79	77	79	70	73	78	80
251	91	88	88	84	84	80	79	81	84	79	76	83	68	68	73	75
252	90	93	93	84	84	84	79	79	82	84	79	86	70	72	75	77
253	91	92	89	86	84	85	77	76	78	86	81	93	75	75	80	84
254	93	92	91	88	86	81	82	74	80	79	81	90	86	79	84	88
255	90	89	88	89	89	86	81	76	79	79	79	90	87	77	80	88
256	91	92	91	91	90	90	84	79	79	77	73	91	89	82	80	89
257	90	91	90	89	91	89	88	80	72	78	79	79	91	87	82	87
258	90	90	87	85	92	89	87	84	74	78	85	85	96	91	87	83
259	91	89	87	85	90	87	88	84	80	78	85	88	85	91	87	85
260	93	94	91	96	89	88	87	87	82	77	85	88	90	89	89	90
261	101	99	97	102	90	90	84	88	85	79	79	87	93	87	88	91
262	103	104	108	100	92	89	83	85	85	83	82	91	96	92	87	92
263	100	98	101	96	93	89	84	81	86	87	83	85	89	94	87	91

Appendix B

Output Test Image

Output Test Image: normimag.dat

Lines	Samples														
	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263
248	-127	80	107	114	97	96	75	98	-126	67	95	73	76	75	91	77
249	-124	104	79	118	93	104	83	102	-114	84	70	77	85	84	87	99
250	-116	116	91	102	109	100	87	94	122	79	70	77	38	50	70	77
251	-120	123	123	106	105	88	83	90	101	79	66	94	30	29	49	56
252	-124	-113	-114	106	105	104	83	82	93	100	78	107	39	46	57	65
253	-120	-117	126	114	105	108	75	69	76	108	87	-120	60	59	78	94
254	-113	-117	-122	121	113	92	95	61	85	80	87	123	106	75	95	111
255	-124	127	122	125	124	112	91	69	81	80	79	123	110	67	79	111
256	-121	-117	-122	-123	-128	-128	103	82	81	71	54	127	118	88	79	115
257	-125	-122	-126	125	-124	123	119	86	52	76	79	78	126	109	87	107
258	-125	-126	118	109	-120	123	115	102	60	76	103	102	-109	125	108	90
259	-121	126	118	109	-128	115	118	102	85	76	103	114	101	125	108	99
260	-113	-110	-123	-104	124	119	114	114	93	72	103	114	122	117	116	119
261	-83	-91	-99	-80	-128	127	102	117	105	80	79	110	-122	109	112	123
262	-75	-72	-57	-88	-121	123	98	105	105	96	91	126	-110	-127	108	127
263	-87	-95	-84	-104	-117	123	102	90	109	112	95	102	117	-119	108	123

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The Wallis Normalization Image Enhancement (WNIE) software module is a general purpose digital processing function that normalizes the pixel values for a given input image. The process permits the user to accept default values or input the desired mean and standard deviation required for the output image. The function creates a new image that raises the contrast in low contrast regions and lowers the contrast in those sections that are too high. This allows the user to view the entire image with one enhancement that brings out the majority of features, whether they be sea surface temperature gradients in an infrared ocean image of sea ice features (floes, leads, etc.) in a visible or infrared polar image. The speed and flexibility of the wallis filter is a powerful tool the operator can implement to increase the image content readily extracted.

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